UNITARY ATTIC RAFTER VENT AND INSULATION DAM ASSEMBLY

Cross-reference to prior applications

This application claims the benefit of U.S. Provisional Application No. 60/438,943 filed January 8, 2003 and U.S. Provisional Application No. 60/503,744 filed September 17, 2003.

Background of the Invention

The present invention relates generally to structures used to establish and maintain ventilation or air flow between a soffit region of a building roof, such as a pitched building roof, and open attic space and particularly to such structures that also function as insulation dams to prevent insulation, especially loose fill insulation, in an attic from flowing down over an upper wall plate into the soffit region. The present invention relates more particularly to such structures that are formed from a single piece of polyolefin foam, preferably an extruded or extrusion molded polyolefin foam and more preferably an extruded propylene polymer foam.

Proper ventilation of an open attic space, particularly attic spaces formed at least in part by a gable roof, provides benefits that vary with the season. In warm months, such ventilation helps cool the attic space by drawing in relatively cooler air from outside the building by way of vents in the soffit region and expelling relatively warmer air from the attic space by way of attic vents or ridge vents. In cool or cold months when buildings are heated, such ventilation minimizes or eliminates ice dam formation that, in turn, causes water to back up under shingles and leak into the building when the ice melts.

Ice dams form due to thermal gradients between a warm attic peak area that promotes melting of snow and ice accumulated on a building roof and a relatively cool eave area where the water from melting snow and ice freezes to form ice packs. The ice packs effectively stop such water from running off the roof and act as dams that redirect such water and promote seepage of the water under shingles that constitute an outer roof surface.

One means of minimizing, if not eliminating, thermal gradients involves insulating the open attic space by placing insulation batts or blankets or blown in or loose fill insulation between successive ceiling joists or, where preformed trusses are used to fabricate a roof structure, between successive ceiling joist segments of such trusses. In some structures, one finds both insulation batts and loose fill insulation as building

occupants seek to improve insulation values within the attic space. The use of blown in or loose fill insulation leads to a potential problem in that the insulation tends to spill over into soffit spaces. When that happens, the loose fill insulation can, and often does, block soffit region vents and effectively eliminate air flow between the soffit region and the attic space, thereby losing desired cooling during warm weather and promoting an undesirable thermal gradient during cold weather.

When loose fill insulation is used to insulate rooms situated directly below an open attic space from air contained in the open attic space, one technique currently used to prevent flow of the loose fill insulation from the attic space down into the soffit region involves use of an insulation dam. The insulation dam may be used in conjunction with a vent means such as a chute.

United States Patent (USP) 4,197,683 discloses a two piece vent and insulation dam or baffle assembly. The vent is an elongated arcurate member with outwardly directed flanges adapted to be secured to the underside of boards that form a roof deck of a gabled roof. The insulation dam or baffle is a block having a semi-circular recess to accommodate and support one end of the vent. Foamed plastics serve as suitable materials from which to fabricate the vent and baffle. The vent and baffle are installed in separate steps, with vent installation requiring one to work in a cramped space that is established by intersecting ceiling joists and rafters in a pitched or gabled roof. In addition to being physically challenging, such an installation is time consuming and costly.

A number of references disclose a one piece structure that functions as both a vent and an insulation dam.

USP 3,160,987 provides a preformed dam and air deflector assembly fabricated from paper or fiber sheet material for fixed attachment between spaced-apart adjacent roof rafters. The assembly includes a number of score lines that permit bending of assembly portions to form side tabs and an end tab. The tabs facilitate fastening the assembly to inner surfaces of roof rafters, ceiling joists or both, as well as to an outer surface of a wall plate. Such a structure still requires one to work in the cramped space, perhaps with a partner working in the soffit space to assist in proper placement and fastening.

USP 3,972,164 positions a preformed insulating member, suitably a foamed plastic material, between adjacent rafters of a roof. The member includes a lower surface that rests on the ceiling and an inclined upper surface that bears against the undersurface of

the roof deck. The upper surface has defined therein a plurality of grooves or recess that, in combination with the roof deck, define air passages. The member's outer edge may have a downwardly extending flange or lip that engages the outer surface of the top plate to facilitate positioning of the member. Placement of the member still requires one to work in the cramped space unless the member is placed between the rafters before construction of the roof deck. The requirement for both a grooved, inclined upper surface and a lower surface that rests against the ceiling leads one to consider costly approaches such as an intricately designed hollow structure or use a large quantity of foam or both.

USP 4,660,463 highlights a roof space ventilator that includes a base member, a support means affixed to the base member for supporting the base member at an acute angle and a flexible member extending from the support means for adjusting the orientation of the base member and support member. The base member has affixed thereto a plurality of ribs that extend above the base member and form a plurality of ventilation channels. Strengthening ribs positioned at an angle, such as 90°, to said ribs provide transverse reinforcement but do not block the ventilation channels. The ventilator, desirably made of a thermoplastic material and preferably vacuum formed, constitutes a complex structure that does little to solve the problem of working in a cramped attic space during ventilator installation.

USP 5,600,928 discloses a roof vent panel for a sloping roof that is a relatively large elongated panel formed from extruded polystyrene foamed sheet. The panel has lateral flanges that facilitate fastening of the panel to the underside of roof sheathing. An offset wall forms a trough between the flanges that extends the length of the panel. The trough is divided longitudinally by a generally triangular ridge that has a height equal to the depth of the trough. The panel does not function as an insulation dam. In addition, polystyrene foam sheeting, particularly a relatively thin molded polystyrene foam sheet, tends to be quite brittle and fractures or breaks when subjected to a bending stress about a sharp edge such as would be encountered if one were to try to bend the sheet against the upper wall plate of a gabled or sloping roof in order to make the sheet function as both a vent panel and an insulation dam. By devoting a significant portion of the structure to use as flanges for attachment to the upper sloping roof deck, one effectively and significantly reduces potential air flow between the soffit area to the open attic space.

USP 6,347,991 presents a solution to the bending problem inherent in the panel of USP 5,600,928 by focusing upon a one-piece, hinged vent chute that includes an elongated chute segment and an insulation dam segment. One or more upwardly open channels that extend from a lower end to an upper end of the elongated chute segment establish a corresponding number of air channels. A hinge or fold line permits the insulation dam segment to be folded or bent downward at the hinge or fold line relative to the chute segment and secured in place to form an insulation dam. Suitable materials of construction include extruded polystyrene foam, paperboard, molded acrylonitrile-butadiene-styrene (ABS) and extruded polyvinyl chloride (PVC). The hinge or fold line creates a line or area of weakness once the line is creased. This normally leads, in turn, to a requirement to fasten the elongated chute segment to the underside of roof sheathing. The single piece construction, while advantaged over a two piece construction, still requires working in the cramped attic space near the soffits and either a two person crew to install the vent chute or a single person performing one step from the soffit side to fasten the insulation dam segment and a second step inside the attic space to fasten the elongated chute segment to the underside of the roof sheathing. Fastening the elongated chute segment also translates to a requirement to use a significant portion of the chute for a purpose other than promoting airflow.

An object of the present invention is to provide a simple article that serves as both an insulation dam and an insulation vent and yet can be installed by a single person who need not enter the attic space to install the article.

Summary of the Invention

A first aspect of the present invention is an unitary attic rafter vent and insulation dam assembly, the assembly comprising a generally rectangular, flexible polyolefin foam body, the body having a first major, preferably planar, surface, a second major surface spaced apart from the first major surface, a first end and a second end, the ends preferably being generally parallel to, but spaced apart from, each other and connecting the first and second major surfaces, and a thickness dimension established by spacing between the major surfaces, the thickness being sufficient to accommodate at least one of (a) at least two grooves in the second surface that longitudinally traverse the second surface and provide fluid communication between the first and second ends or (b) at least one conduit disposed between the major surfaces and in fluid communication with both the first

and second ends, the body being sufficiently flexible to withstand bending at a 90° angle without cracking or rupturing either major surface or sealing off fluid communication via the grooves, conduits or both and having a modulus sufficient to allow the assembly to rebound by at least 20° when bent at said 90° angle. The polyolefin foam body is desirably an extruded polyolefin foam body, an extrusion molded polyolefin foam body or a molded, expanded polyolefin foam bead body. The polyolefin foam body is preferably an extruded polyolefin foam body.

A second, but related aspect of the present invention is a method of establishing and maintaining air flow between soffit vents and attic vents in a building construction with a pitched roof, the building construction comprising an exterior vertical wall, a ceiling supported by the wall and placed against ceiling joists or ceiling joist segments of rafter trusses, a roof supported by the wall and including a plurality of spaced rafters or rafter trusses that are secured to an upper surface of the wall and a roof deck supported by the rafters or rafter segments of the trusses, the soffit vents being disposed outwardly of the exterior wall and the attic vents being disposed inwardly of the exterior wall, the method comprising (a) orienting the unitary attic rafter vent and insulation dam assembly of first aspect such that the first major planar surface faces away from the roof deck, (b) inserting one end of the assembly into a space formed by two adjacent rafters or rafter segments of trusses, (c) bending the assembly proximate to the other end such that at least a portion of the major planar surface comes into operative contact with a portion of the exterior wall proximate to a juncture formed by the rafters, or rafter joist segments of trusses, and the upper surface of the wall, and (d) securing the major planar surface portion to the exterior wall portion.

A third aspect of the present invention constitutes a variation of the second aspect. The third aspect, like the second aspect, is a method of establishing and maintaining air flow between soffit vents and attic vents in a building construction with a pitched roof. As with the second aspect, the building construction comprises an exterior vertical wall, a ceiling supported by the wall and placed against ceiling joists or ceiling joist segments of rafter trusses, a roof supported by the wall and including a plurality of spaced rafters or rafter trusses that are secured to an upper surface of the wall and a roof deck supported by the rafters or rafter segments of the trusses, the soffit vents being disposed outwardly of the exterior wall and the attic vents being disposed inwardly of the exterior wall. The method

comprises (a) orienting the unitary attic rafter vent and insulation dam assembly of the first aspect in the same manner as in the second aspect, (b) placing the first end of said assembly against the ceiling at a distance from the wall, (c) applying a bending force to said first end sufficient to cause at least a portion of the first major surface of the assembly proximate to said first end to form an acute angle with that portion of the first major surface distant from said first end, and (d) inserting the second end of the assembly into a space formed by two adjacent rafters or rafter segments of trusses. If desired, one can switch the first and second ends and achieve the same effect.

The third aspect lends itself to at least three modifications. The modifications may be used singly or in any combination.

One modification imparts a bevel to one end of the assembly, nominally the first end, to provide a beveled, preferably planar, surface that intersects the first major surface of said assembly at an acute angle and the second major surface of said assembly at an obtuse angle.

A second modification (a) secures the first end to the ceiling or (b) secures the second end to the roof deck or rafters or truss rafter segments or both or (c) secures both the first end as in (a) and the second end as in (b).

A third modification imparts at least one transverse groove, crease, cut, perforation or indentation (collectively referred to as "groove") in the first major planar surface proximate to the end, nominally the first end, that is placed against the ceiling and distant from the other end, nominally the second end.

Brief Description of the Drawings

Figure (Fig.) 1 is a fragmentary perspective view of a roof construction incorporating the unitary attic rafter vent and insulation dam assembly of the present invention.

Fig. 2 is perspective view of a unitary attic rafter vent and insulation dam assembly of the present invention in an unbent configuration.

Fig. 3 is a cross-sectional view of the assembly of Fig. 2 taken along section line 3-3.

Fig. 4 is an end view of a unitary attic rafter vent and insulation dam assembly of the present invention that has a different profile than the assembly of Fig. 2.

Fig. 5 is an end view of the assembly of Fig. 4 that illustrates partial compression of the assembly to aid in a friction fit between adjacent rafters or rafter joist segments of prefabricated trusses.

Figs. 6 and 7 are end views of additional profiles for unitary attic rafter vent and insulation dam assemblies of the present invention.

Fig. 8 is a fragmentary perspective view of a unitary attic rafter vent and insulation dam assembly of the present invention that shows both internal conduits and surface channels or grooves.

Fig. 9 is a perspective view of yet another profile for a unitary attic rafter vent and insulation dam assembly of the present invention.

Figs. 10-13 are fragmentary end views of still more profile possibilities for a unitary attic rafter vent and insulation dam assembly of the present invention.

Description of the Preferred Embodiments

In Figs. 1-13, use of a single reference numeral in two or more Figs. indicates use of the same component in each Fig. The use of a single prime (') or double prime (") after a reference numeral represents a minor variation of the feature or element identified by the reference numeral. The use of a multiple of 100 to precede a reference numeral, e.g. 160 versus 60, means that the feature or element has a similar, if not identical, function in each Fig. even if the feature or element contains more than minor variations.

Fig. 1 illustrates a typical building construction 10 that includes an exterior wall 11, a ceiling 21 and a roof 31.

Wall 11 comprises a plurality of spaced-apart, vertical studs 12 (not shown) and a top or sill plate 14 connected to upper ends (not shown) of the studs. Outer sheathing 16 (shown in part) covers outer surfaces of studs 12 and a layer of siding or other exterior surface material 18 (not shown) may be applied over outer sheathing 16 to form the building's exterior wall. If desired, a housewrap or vapor barrier material 17 (not shown) may be applied to outer sheathing 16 before siding or exterior surface material 18 is applied over said sheathing 16. Sheets of plaster board 13 (not shown) or other interior surface material covers inner surfaces of studs 12 and insulation 15 (not shown) can be installed within cavities formed by studs 12, outer sheathing 18 and plaster board 13.

A plurality of prefabricated rafter trusses 20 (shown in part in Fig. 1) rest on top or sill plate 14. Each truss 20 comprises a ceiling joist segment 22, an end portion of

which rests on and is secured to top or sill plate 14 of a wall 11, two intersecting, but opposed, rafter segments 32 (only a part of one rafter segment is shown in Fig. 1) that intersect in butt joints with opposite ends of a joist segment 22, the butt joint being spaced apart from, but proximate to, an end of the rafter segment 32 such that the ceiling joist end portion that rests on sill plate 14 is part of the butt joint , a plurality of reinforcing struts 37 that butt up against both a joist segment 22 and a rafter segment 32 and a plurality of fasteners 38 that fix butt joints between, as appropriate, ceiling joist segment 22 and reinforcing strut 37, rafter segment 32 and reinforcing strut 37 and ceiling joist segment 22 and rafter segment 32.

Ceiling 21 comprises the ceiling joist segments 22 of a plurality of spaced-apart rafter trusses 20 and a surface layer 23 formed by sheets of plaster board or other interior surface material that are attached to undersides of joist segments 22 to form ceiling surfaces for interior rooms of building construction 10. Insulation 29 (not shown), in the form of batts or blankets or blown in or loose fill insulation, may be disposed between ceiling joist segments 22 of successive rafter trusses 20.

Roof 31 includes the plurality of spaced-apart rafter trusses 20 and a roof deck 33 that is composed of a layer of sheathing or plywood attached to upper surfaces of rafter segments 32 of said trusses 20. Roof deck 33 is, in turn covered by a layer of barrier material 34. Tar paper functions as a suitable barrier material 34. An outer roofing material 35, such as a layer of shingles, overlays barrier material 34. Roof 31 desirably includes at least one venting mechanism 39 (not shown). Suitable venting mechanisms 39 include, without limitation, louvered ridge vents.

Building construction 10 includes an attic space 27 bounded by top or sill plate 14, ceiling 21 and roof 31. Attic space 27 may have venting mechanisms 28 (not shown) in addition to or in place of venting mechanisms 39. Venting mechanisms 28 include, without limitation, louvered vents over an aperture (not shown) in a building exterior wall (not shown) near a roof peak formed when cooperating rafter segments 32 meet at a point distant from sill plate 14. A house fan (not shown) may be used to enhance air flow if desired.

A facia board or panel 41 abuts lower ends of rafter segments 32. A soffit 43 spans a space between, and is secured to, outer sheathing 16 and facia board or panel 41. A vent 45 is provided in soffit 43 to facilitate a flow of air through soffit 43 and into attic

space 27. If either or both of venting mechanisms 39 (e.g. ridge vents) and venting mechanisms 28 are present in building structure 10, the flow of air continues through attic space 27 and out of said venting mechanisms 28, 39 or both.

According to the second aspect of the present invention, a plurality of unitary attic rafter vent and insulation dam assemblies 60, one of which is shown in Fig. 1, are placed between adjacent rafter joist segments 32. Each assembly 60 has a first end 61 that is preferably fastened to an outer surface portion of exterior sheathing 16 proximate to where exterior sheathing 16 abuts, and is operatively connected to, top or sill plate 14. A plurality of fasteners 62, such as staples or flat headed nails, desirably affix first end 61 to exterior sheathing 16. If desired, an adhesive may be used in place of, or in addition to, fasteners 62. Skilled artisans readily understand that a variety of fasteners, adhesives or both may be used to secure end 61 to exterior sheathing 16. By so securing end 61, one establishes an insulation dam to prevent loose fill insulation from spilling over top or sill plate 14 and onto soffit 43 such that it blocks vent 45.

Each assembly 60 also has a second end 64 (not shown) that is spaced apart from first end 61. Each assembly 60 further has a first surface 63 (not shown) and a second surface 65. First surface 63 preferably has, in an unbent configuration, a generally planar character. In other words, first surface 63 can lie flat on a floor and leave no channels or air gaps. Such a character facilitates blocking the flow of loose fill insulation from the attic space 27 onto soffit 43. Second surface 65 desirably has defined therein a plurality of grooves or flutes 66. Ridges 67 separate the grooves or flutes 66 from each other. The grooves or flutes 66 facilitate airflow between vent 45 in soffit 43 and attic space 27. Second end 64 of assembly preferably rests against the underside of roof deck 33 in such a manner that compression of ridges 67 between the flutes 66 is minimized and airflow is maximized. One need not place second surface 65 of assembly 60 directly against roof deck 33 at a point proximate to top or sill plate 14, but may achieve desirable results if only a portion of second surface 65 proximate to second end 64 (not shown) rests against roof deck 33. Suitable results may also be obtained if no portion of second surface 65 proximate to second end 64 rests against roof deck 33 so long as at least second end 64 is disposed, preferably by compression fit, between adjacent rafter segments 32. Improved results may be expected if more than second end 64 of assembly 60, but not all of assembly 60, is so disposed.

Fig. 2 illustrates a first alternate unitary attic rafter vent and insulation dam assembly designated by reference numeral 160. Assembly 160, like assembly 60, has a first end 161, a second end 164, a first surface 163 and a second surface 165. First surface 163, like surface 63 of assembly 60, is preferably planar. As assembly 160 is a symmetric structure, either first end 161 or second end 164 may be operatively connected to an outer surface portion of exterior sheathing 16 proximate to where exterior sheathing 16 abuts, and is operatively connected to, top or sill plate 14 in the same manner as described above for first end 61 of assembly 60. Second surface 165 has defined therein a plurality of grooves or flutes 166. The flutes 166 desirably have a "v-shaped" configuration, with adjacent flutes 166 meeting at a sharp ridge line 167 formed by intersecting planes that comprise walls of the v-shaped configuration. A variation, not shown, of assembly 160 uses a truncated ridge 167' or a rounded ridge 167" to provide an increase in compression resistance over that available with sharp ridge line 167.

Fig. 3 is a cross section of assembly 160 taken along section line 3-3 in Fig. 2. Fig. 3 more clearly shows first surface 163 as a planar surface and second surface 165 as a series of intersecting v-shaped grooves.

Fig. 4 is an end view of an assembly 260. Assembly 260 has a first surface 263 that is preferably planar as is surface 63 of assembly 60 and a second surface 265 that differs from the second surfaces 65 and 165 of, respectively, assembly 60 and assembly 160. Second surface 265 comprises a plurality of spaced apart truncated, preferably at least partially rounded (as shown in Fig. 4) ridges 267. Spacing preferably occurs by way of alternating valleys 266. While the valleys 266 shown in Fig. 4 are planar and generally parallel to first surface 263, that is simply one option for a valley that maximizes volume available for air flow channels while preserving sufficient mass between the floor of valleys 266 and first surface 263 to give assembly 260 enough strength to withstand a tendency to droop due to inadequate stiffness under influence of gravity. As long as assembly 260 provides sufficient air flow space, valleys 266 may take on any profile that can be fabricated, machined or otherwise imposed upon second surface 265. Assembly 260 also has first side 268 and second side 269. First side 268 is spaced apart from and, as shown in Figs. 4 and 5, preferably parallel to second side 269. First side 268 and second side 269 need not, however, be either planar, although that is preferred from a fabrication point of view, or parallel. First side 268 and second side 269 may be sloped so that they converge

toward, or diverge from, first surface 263. In fact, any geometric shape may be used so long as sufficient surface portions of first side 268 and second side 269 frictionally engage with opposed inner surfaces of adjacent rafter segments 32 when second end 264 (not shown) is preferably disposed between said rafter segments 32.

Fig. 5 shows assembly 260 as disposed between adjacent rafter segments 32 and abutted against roof deck 33. Fig. 5 shows some compression of first side 268 and second side 269 to facilitate fitting assembly 260 by friction fit between rafter segments 32. A friction fit, while desirable, is not essential provided assembly 260 and its analogues (e.g. assemblies 60, 160, 260, 260', 660, 660', 660" and 660'") have sufficient stiffness to cause a ridge portion near an end of an assembly (e.g. ridges 167 proximate to end second 164 of assembly 160 (when first end 161 is attached to exterior sheathing 16 proximate to sill 14)) to remain close to, if not rest against, roof deck 33.

Fig. 6 shows an end view of assembly 260'. Assembly 260' represents a variation of assembly 260 with ridges 267' that are narrower and more rounded than ridges 267 and valleys 266' that are wider than valleys 266.

Fig. 7 is an end view of assembly 360 which has a first, preferably planar surface 363 and a second surface 365 that resembles a sinusoidal curve with spaced apart rounded ridges or peaks 367 that are separated by rounded valleys 366. Assembly 360 has a first side 368 and a second side 369. As illustrated, first side 368 is established by bisecting a valley 366 and second side 369 is established by bisecting a peak or ridge 367. Skilled artisans may make any number of variations of, for example, peak and valley shape and spacing for second surface 365, shape and profile of first side 368 and second side 369 and points of intersection on second surface 365 where cuts are made to establish first side 368 and 369, without departing from the spirit and scope of the present invention.

Fig. 8 is a partial or fragmentary perspective view of assembly 460. Assembly 460 has a first end 461, a second end 464 (not shown), a first surface 463, a second surface 465, a first side 468 and a second side 469. Assembly 460 has defined therein a plurality of passageways or conduits 462 that extend from first end 461 through assembly to second end 464 and provide fluid communication between ends 461 and 464. While Fig. 8 shows passageways 462 as having a square cross-section, skilled artisans readily understand than one can vary the size, shape and spacing of passageways 462 without departing from the scope and spirit of the present invention. First surface 463 and

second surface 465 both have a profile that resembles a plurality of intersecting arcurate projections 467 that establish narrow V-shaped valleys 466 at their points of intersection. First side 468 and second side 469 both have a profile that resembles a plurality of square projections 470 separated by flat-bottomed valleys 471. As with passageways 462, skilled artisans may change the shape, spacing and character of any or all of first surface 463, second surface 465, first side 468 and second side 469 without going beyond the spirit and scope of the present invention. By way of example, first surface 463 may be replaced by a planar counterpart designated as 463' (not shown). Similarly, first side 468 and second side 469 may be replaced, respectively, by planar counterparts 468' (not shown) and 469' (not shown).

Fig. 9 is a broken perspective view of assembly 560. Assembly 560 resembles assemblies 160, 260, 260' and 360 in that it has a generally planar first surface 563 and a second surface 565 with a profile represented by a plurality of ridges or peaks 567 separated by valleys 566. As shown ridges or peaks 567 are solid geometrical shapes that may be characterized as either trapezoidal or truncated isosceles triangles. As shown in Fig. 9, valleys 566 are much wider than the ridges or peaks 567 that separate valleys. Assembly 560 also has a first side 568 and a second side 569. Fig 9 shows a preferred shape for first and second sides 568 and 569, both established by a planar, preferably perpendicular bisection of spaced apart peaks 567. Assembly 560 also has a first end 561 and a second end 564.

Figs. 10-13 show a series of fragmentary end views of four variations of a single theme for an assembly 660, the variations being designated, respectively, as 660, 660', 660" and 660'". For simplicity, a description of assembly 660 applies equally to its analogues designated as assemblies 660', 660" and 660'" save for minor variations in spacing between and width of peaks 667, width of valleys 666 and thickness of assembly 660 as measured between first surface 663 and valley 666. As such, any reference to assembly 660 in Fig. 10 also applies to its analogues in Figs. 11-13. First surface 663 is, like first surfaces 163, 263, 263', 363 and 563, preferably planar for the reason specified in discussing first surface 163. First surface 663 may, however, have a shape like that of first surface 463 if so desired. Peaks 667 are solid geometrical shapes or projections that are slightly rounded at their apex. Valleys 666 are preferably flat and generally parallel to first surface 663. Assembly 660 differs from assembly 660' primarily in terms of thickness and

from assembly 660" in terms of both thickness and spacing between peaks or width of valleys. Assembly 660 differs from assembly 660''' in terms of number of peaks, peak base width, valley width and assembly thickness. The desired spacing between the peaks 667 and the thickness of the assembly at the valley 666 is determined by the properties of materials used to fabricate the assembly. In preferred embodiments, the material is a flexible polyolefin foam and relevant properties include polymer type and foam density. As with other assemblies, skilled artisans may make any number of further variations of peak geometry, number of peaks and spacing between peaks without going outside the scope, content and spirit of the present invention as long as the resulting assembly has sufficient flexibility to ease installation, sufficient stiffness so that its unfastened end remains well above a surface established by insulation placed between ceiling joist segments 22 of trusses 20 for a desirable length of time, and sufficient air flow channels or conduits to promote ventilation of attic space 27.

Any of unitary attic rafter vent and insulation dam assemblies 60 through 660''' of the present invention may be easily installed by a single individual either in new home construction or, with some advance work, remodeling existing home construction. The processes presented in the second and third aspects provide two alternated procedures for installation. Even though the following discussion focuses upon assembly 60, the discussion applies equally to its analogues designated assemblies 160 though 660'''.

When one practices the process of the second aspect of the invention in new home construction, installation of the assembly 60 occurs before soffit 43 and facia 41 are put in place and secured to building construction 10. The individual simply slides most of the length of an assembly 60 between adjacent rafter segments 32 with second or profiled surface 65 facing upward toward roof deck 33 and then bends an end portion of assembly 60 proximate to end 61 downward so that it is in contact with an outer surface portion of exterior sheathing 16 proximate to where exterior sheathing 16 abuts, and is operatively connected to, top or sill plate 14 of a structure 10 and secures the end portion in place with adhesives, fasteners 62 or both. There is no need for a second individual to stand in attic space 27 to guide assembly 60 into place. After installation of assembly 60 between each pair of rafter segments 32, one may install facia 41 and soffit 43. In remodeling, one must first remove soffit 43 and, in some cases, facia 41 before proceeding as described above to install assembly 60.

Installation of assembly 60 in accord with the third aspect of the invention also finds use in either new home construction or remodeling of existing structures. In contrast to the second aspect, the third aspect allows omission of the additional steps of removing and thereafter replacing soffit 43 and, in some cases, facia 41. Assembly 60 may be installed either before or after roof deck 33 is placed on rafter segments 32 so long as one end assembly 60 is held in place between adjacent rafter segments 32 by friction fit, a fastening means (not shown) or both. The other end of assembly 60 may, if desired, be fastened or secured to ceiling 21 by fastening means (not shown).

Practice of the third aspect desirably begins by orienting assembly 60 such that the second or profiled surface 65 faces downward toward ceiling 21 and away from rafter segments 32. Practice continues by placing at least a surface portion of second surface 65 proximate to, preferably coincident with, first end 61 of assembly 60 against ceiling 21 at a distance from the exterior wall not shown, preferably spaced apart from sill plate 14 toward the interior of attic 27. The distance, which is not particularly critical, simply needs to be sufficient to allow a portion of first end 61 to be in contact with ceiling 21 and permit assembly 60 to bend back upon itself to form an acute angle such that the balance of assembly 60 has its second surface 65 facing toward rafter segments 32. The acute angle is measured between segments of first surface 63 (not shown) closest to sill plate 14. Once the surface portion of second surface 65 is placed in contact with ceiling 21, one then applies a bending force to assembly 60 sufficient to cause it to bend back upon itself and form the acute angle. Practice of the third aspect concludes by inserting second end 64 of assembly 60 into a space formed by two adjacent rafters (not shown) or rafter segments 32. If desired, one can switch first end 61 and second end 64 and achieve the same effect.

The third aspect lends itself to at least three modifications. The modifications may be used singly or in any combination.

One modification imparts a bevel to that end of assembly 60, nominally first end 61, to provide a beveled, preferably planar, surface 59 (not shown) that intersects first surface 63 of assembly 60 at an acute angle and second surface 65 of assembly 60 at an obtuse angle. In other words, the beveled, preferably planar, surface 59 intersects first surface 63 proximate to first end 61 and second surface 65 distant from first end 61. The magnitude of the acute angle is not particularly important so long as at least a portion of the beveled surface 59 is in operative contact, preferably physical contact, with ceiling 21.

More preferably, a major portion of beveled surface 59 is in physical contact with ceiling 21. Physical contact between all of beveled surface 59 and ceiling 21, while desirable, is not necessary. The contact need simply be sufficient to substantially preclude, preferably bar, the passage of blown in insulation between the beveled surface and the ceiling.

A second modification (a) secures first end 61 to ceiling 21 or (b) secures second end 64 to roof deck 33 or rafter segments 32 or both or (c) secures both the first end 61 as in (a) and the second end 64 as in (b).

A third modification imparts at least one transverse groove, crease, cut, perforation or indentation (collectively "groove") 58 (not shown) in the first surface 63 proximate to the end, nominally first end 61, that is placed against ceiling 21 and distant from the other end, nominally second end 64.

Transverse groove(s) 58 may extend all the way across first surface 63 or just be pressed, cut, machined, stamped or perforated into first surface 63 opposite the longitudinal grooves or flutes 66 in second surface 65. Groove(s) 58 preferably have an orientation parallel to first end 61 and perpendicular to grooves or flutes in the second surface (e.g. grooves or flutes 66 in second surface 65). Groove(s) 58 facilitate(s) bending assembly 60 back on itself to form the acute angle. The groove(s) extend from first surface 63 toward second surface 65, but either do not intersect at all with second surface or, more preferably, do not intersect completely with second surface 65.

Grooves 66 may be thought of as "valleys" and spaces between such grooves may be thought of as "peaks". Using that terminology, grooves 58 more preferably intersect and are in fluid communication with at least a portion of grooves or valleys 66, but not with the peaks. The fluid communication should not, however, be so extensive that blown insulation can escape from attic space 27 by way of such intersections and proceed into soffit 43 .

While it might be possible to completely sever assembly 60 and then use a fastening means to reassemble it and hold it in place, groove(s) 58 is/are preferably sufficiently deep to facilitate bending, yet sufficiently shallow to maintain the structural integrity of assembly 60. In other words, sufficient material remains such that assembly 60 does not fracture or break during bending or installation of assembly 60.

If desired, all or part of second surface 65 may be reinforced by known means including, without limit, a layer of a polymeric film that covers at least that portion of

second surface 65 designated as peaks and located opposite groove(s) 58 in first surface 63, as well as use of one or more strips of a plastic adhesive tape or an adhesive, fabric-reinforced tape. For ease of manufacture, the polymeric film layer (not shown) may cover substantially all of second surface 65. The strips of tape (also not shown) may be aligned in any direction or combination of directions so long as they function to reinforce assembly 60 and minimize, preferably eliminate, breakage of assembly 60 at or near the grooves 58.

The unitary attic rafter vent and insulation dam assembly of the present invention, whether as depicted in any of Figs. 1-13 or as modified based upon variations discussed above, comprises an extruded or extrusion molded, generally rectangular, flexible polyolefin foam body. The body has a first surface, preferably planar, and a second surface that is spaced apart from the first surface. The second surface may or may not have a surface portion that is parallel or even approximately parallel to the first surface. For example, Figs. 4-6 and 9-13 show flat valleys that are generally parallel, if not exactly parallel, to the first surface whereas Figs. 1-3, 7 and 8 are more properly characterized as having non-flat (e.g. Fig. 7) or V-shaped (e.g. Figs. 1-3 and 8) valleys. The second surface has a number of geometric shapes, preferably solid, projecting therefrom that are otherwise known as peaks or ridges. If one were to lay a flat, planar sheet across those peaks that project furthest from the second surface, that sheet would preferably parallel the first surface. With that plane in place and, if necessary, planes laid against spaced-apart, preferably parallel, first and second sides that are preferably normal to at least the first surface, one may readily visualize the generally rectangular shape desired of the polyolefin foam body. This holds true irrespective of the shape or profile of the first and second sides. While many of the Figs. show a flat character for the first and second sides, Fig. 8 shows a variation that yields desired results. Other variations, such as sides that slope toward, or away from, each other, should, and preferably do, yield similar results.

The polyolefin foam body is preferably an extruded propylene polymer foam body and more preferably an extruded, coalesced foam strand material that is disclosed in, and fabricated according to the process of, United States Application Serial Number 09/802383, filed 9 March 2001, that claims priority from United States Provisional Application Serial Number 60/190720 (filed 17 March 2000) and is published in the United States as 2001-0039299 with a publication date of 8 November 2001, the teachings of which are incorporated herein by reference to the maximum extent allowed by law. The

polyolefin, preferably a propylene polymer, foam body has a density of 22 kilograms per cubic meter (kg/m^3) or less ($\leq$), preferably ≤ 20 kg/m^3. While extruded, coalesced foam strand materials are particularly suited for use in the present invention, acceptable results are obtained with extruded foam shapes such as sheets (thickness of one centimeter (cm) or less) or planks (thickness in excess of one cm).

Although propylene polymer foams are preferred, other olefin polymers and olefin polymer blends may be used for a variety of reasons, such as cost or an acceptance of a different balance of physical properties that that offered by propylene polymers.

The polyolefin, preferably polypropylene, foam body may be formed into a desired shape, such as any of the embodiments shown in Figs. 1-13, by any means known in the art. Such means include, without limit, direct extrusion, shaping (e.g. by machining, sawing, cutting or molding) or thermoforming. Known devices such as lasers, hot wires, knives, saws and water jet cutting apparatus may be used to effect the shaping in the absence of a heated mold like that used in thermoforming. The choice of shaping means is not critical so long as the shaped foam is suitable for use in accord with the present invention, particularly as described in conjunction with the second and third aspects of the invention. In other words, the shaped foam functions as a readily installed rafter vent and insulation dam assembly.

The unitary attic rafter vent and insulation dam assembly of the present invention has a maximum thickness dimension, measured from first surface to a point on the second surface perpendicular to the first surface and most distant from the first surface, of at least one inch (2.5 centimeters (cm), preferably at least 1.5 inch (3.8 cm), more preferably at least 1.75 inch (4.4 cm) and more preferably at least 2 inches (5.1 cm). The thickness is desirably up to and including a thickness equal to depth of rafters or rafter joist segments. Conventional United States construction practices use nominal 2 x 4 (two inch by four inch or 5.1 cm by 10.2 cm) lumber or, in some northern states, nominal 2 x 6 (two inch by six inch or 5.1 cm by 15.1 cm) lumber, to fabricate rafters or rafter segments of trusses. Skilled artisans understand that a nominal 2 x 4 has actual dimensions of 1.75 inch by 3.5 inch (4.4 cm by 8.9 cm) and a nominal 2 x 6 has actual dimensions of 1.75 inch by 5.5 inch (4.4 cm by 14 cm). With that in mind, the assembly thickness is desirably no more than 3.5 inches (8.9 cm) for nominal 2 x 4 rafters and no more than 5.5 inch (14 cm) for 2 x 6 rafters. For 2 x 6 rafters, the assembly thickness is preferably no more than 5 inches (12.7 cm), more

preferably no more than 4 inches (10.2 cm) and still more preferably no more than 3 inches (7.6 cm). For 2 x 4 rafters, the assembly thickness is preferably no more than 3 inches (7.6 cm) The assembly also has a minimum thickness dimension, measured from its first surface to a point on the second surface perpendicular to the first surface and closest to the first surface and independent of rafter dimensions, of from about 0.25 inch (0.635 cm) to about 2 inch (5.08 cm), preferably from about 0.5 inch (1.27 cm) to about 1 inch (2.54 cm). A minimum thickness dimension of less than 0.25 inch (0.635 cm) may cause the assembly to have insufficient stiffness to withstand gravity such that the assembly bends excessively and at least a portion of the assembly lies upon insulation disposed between adjacent floor joist segments. A maximum thickness dimension of more than 2 inch (5.08 cm), while it may perform well from a mechanical point of view, may be prohibitively expensive. Irrespective of the thickness chosen, whether it be the maximum thickness, the minimum thickness or any thickness between the maximum and minimum, grooves in the second surface should be as deep as possible to maximize air flow through channels formed by cooperation of the grooves with the roof deck, yet shallow enough to minimize assembly shape distortion other than side wall wrinkling during and installation of the assembly as described herein.

The assembly desirably has a stiffness or modulus sufficient to allow a portion of the assembly that is subjected to a bending force sufficient to bend that portion at an angle of 90° relative to the balance of the assembly (e.g. from vertical to horizontal) and then freed from the bending force to rebound by at least 20° from its bent configuration. In other words, following release of the bending force, the bent portion recovers from its bent or horizontal configuration towards its original or vertical orientation by at least 20° such that an angle between its unbent configuration and its rebounded configuration does not exceed 70°. The recovery is desirably at least 30°, preferably at least 35°, more preferably at least 40° and most preferably at least 45° such that the angle between its unbent configuration and its rebounded configuration is, respectively no more than 60°, preferably no more than 55°, more preferably no more than 50° and most preferably no more than 45°. In the rebounded configuration, and preferably in the bent configuration as well, the assembly is substantially free of ruptures that at least partially sever the assembly by being in fluid communication with both the first and second surfaces of the assembly. The assembly is even more preferably substantially free of deep cracks that are in fluid communication with one, but not both of the first and second surfaces. The modulus is

preferably sufficient to allow the assembly to rebound enough that ridge portions of the second surface of the assembly proximate to the second end of the assembly rest against a roof deck when installed as described above. The modulus should not be so great that said ridge portions are flattened enough to approach valley floors of the assembly and effectively shut off air flow through channels established by alternating ridges and valleys in cooperation with the roof deck.

As noted above in descriptions of the various Figs., the assembly has a first surface that is desirably planar to maximize its utility as an insulation dam when an end portion of the planar surface is fastened to the exterior wall surface proximate to the sill plate. The planar surface of the assembly, when placed against the exterior wall surface, effectively provides a barrier to passage of loose fill insulation from the attic space into an area bounded in part by the soffit, otherwise known as the "soffit area" or "soffit region". The assembly also has a second surface remote from the first surface that has a profile like that shown in any of Figs. 1-13 or any of the variations discussed above. For purposes of simplicity, the profile may be thought of as alternating ridges and valleys irrespective of the shape of the ridge, shape of the valley or spacing between ridges. This "ridge and valley" profile, also described as a grooved surface wherein a plurality of grooves are defined in the second surface using procedures such as machining, molding or selecting an extrusion die that produces the profile. The "groove" shape would be chosen to provide a desired ridge and valley profile. Machining and molding may be more desired when considering small projects, but use of an extrusion die of the appropriate shape with or without minimal machining or molding should be more cost effective from a commercial point of view.

If desired, a film facer may be applied or operatively connected to one or both of the first and second surfaces of the assembly using techniques known to those skilled in the art. Those techniques include coextrusion, use of an adhesive, thermal lamination and/or thermal heating of the foam surface to produce a thicker durable film layer.

If desired either when installing a roof deck in new construction or when replacing a roof deck during remodeling or repair, one may also install a rafter cap on upper rafter surfaces to divert any water that might penetrate the roof deck into valleys of unitary attic rafter vent and insulation dam assembly of the present invention and, particularly when a film facer is used on the second surface, out of the attic space by way of the soffit vents.

The rafter cap may, for example, be an elongated "U-shaped" rigid, semi-rigid or flexible metal, coated paper or plastic structure that is inverted and placed over a rafter such that the bottom of the U rests at least partially on the upper rafter surfaces and legs of the U overlap proximate portions of adjacent unitary attic rafter vent and insulation dam assemblies.

Published Application 2001-0039299, previously incorporated by reference, also discloses preparation of suitable propylene foam materials using a foam-forming apparatus that comprises a) a foam extrudate receiving roller assembly; b) a second roller assembly, the second roller assembly being connected to the foam extrudate receiving roller assembly by at least one articulated linkage; and c) a foam tensioning assembly, the foam tensioning assembly being spaced apart from, but in operative relation to, the second roller assembly. If desired, a forming plate assembly may replace the second roller assembly or supplement the first and second roller assemblies. As a substitute, the forming plate assembly is preferably connected to the foam extrudate receiving roller assembly by at least one articulated linkage. As a supplement, the forming plate assembly is preferably connected in the same manner to the second roller assembly and spaced apart from, but in operative relation to the foam tensioning assembly. The forming plate assembly preferably has at least one lubricant applicator operatively connected thereto. The lubricant applicator preferably supplies a lubricant material to forming plate assembly surfaces that contact a foam material during operation of the apparatus.

The coalesced foam strand materials desirably result from a polymer composition that comprises an olefin polymer resin selected from the group consisting of an olefin homopolymer, an olefin copolymer, a blend of an olefin homopolymer and an olefin copolymer. The polymer composition may also comprise a thermoplastic resin other than an olefin polymer resin such as, for example, a poly(vinyl aromatic) resin such as polystyrene or a styrene copolymer. The resin is preferably at least one member of a group consisting of an ethylene homopolymer, an ethylene copolymer, a propylene homopolymer or a propylene copolymer or a blend of at least one member of that group with a poly(vinyl aromatic) resin.

Polypropylene (PP) homopolymers and propylene copolymer resins provide satisfactory results when used as the linear polyolefin resin. USP 5,527,573 discloses suitable propylene polymer materials at column 3, lines 27-52, the teachings of which are incorporated herein by reference. The propylene polymer materials include (a) propylene

homopolymers, (b) random and block copolymers of propylene and an olefin selected from ethylene, 1-olefins (α-olefins) containing 4 to 10 carbon atoms ($C_{4\text{-}10}$) and $C_{4\text{-}10}$ dienes, and (c) random terpolymers of propylene and two monomers selected from ethylene and $C_{4\text{-}10}$ α-olefins. The $C_{4\text{-}10}$ α-olefins may be linear or branched, but are preferably linear. Suitable propylene polymer materials have a melt flow rate or MFR (ASTM D-1238, Condition 230°C/2.16 kilograms (kg)) of 0.01 - 100 grams per ten minutes (g/10 min), preferably 0.01 - 50 g/10 min, more preferably 0.05 - 10 g/10 min, and still more preferably 0.1 to 3 g/10 min.

The PP and propylene copolymer resins may, if desired, be high melt strength resins prepared by a branching method known in the art. The methods include irradiation with high energy electron beam (USP 4,916,198), coupling with an azidofunctional silane (USP 4,714,716) and reacting with a peroxide in the presence of a multi-vinyl functional monomer (EP 879,844-A1). Satisfactory results follow, however, from use of less expensive resins or additives.

Suitable results may be obtained with traditional linear ethylene/α-olefin polymers (e.g., heterogeneously branched linear low density polyethylene, linear high density polyethylene, or homogeneously branched linear polyethylene), traditional highly branched low density polyethylene, as well as with linear ethylene/α-olefin polymers and substantially linear ethylene/α-olefin interpolymers.

Polyethylene and ethylene copolymers, particularly ethylene/α-olefin copolymers, can be made using various polymerization techniques, including solution processes, slurry processes and gas phase processes. Solution processes such as that disclosed in USP 4,076,698 (Anderson et al.) are particularly preferred. Anderson et al. disclose heterogeneously branched polyethylene having a relatively broad molecular weight distribution (MWD). Catalyst systems for the various polymerization processes include Ziegler Natta catalyst technology, such as that shown in USP 4,076,698, but also include single site catalyst technology, such as that disclosed in USP 3,645,992 (Elston) and in USP 5,064,802 (Stevens et al.) (constrained geometry catalyst technology). Elston's technology results in homogeneously branched linear polyethylene having a very narrow MWD, while the catalyst technology of Stevens et al., when used in a continuous polymerization process, results in substantially linear polyethylene (having long chain branching levels of 0.01 - 3 long chain branches per 1000 carbons, but also having a very narrow MWD). Other

(metallocene) catalyst technology includes that disclosed in USP 5,026,798 (Canich) and USP 5,055,438 (Canich). Examples of the substantially linear polyethylene can be found in USP 5,272,236 (Lai et al.); USP 5,278,272 (Lai et al.); and USP 5,665,800 (Lai et al.). All of the cited United States Patents are hereby incorporated by reference in their entirety.

The term "linear ethylene/α-olefin polymers" means that the olefin polymer does not have long chain branching. That is, the linear ethylene/α-olefin polymer has an absence of long chain branching, as for example the linear low density polyethylene polymers or linear high density polyethylene polymers made using uniform branching (i.e., homogeneously branched) distribution polymerization processes (e.g., USP 3,645,992 (Elston) and are those in which the comonomer is randomly distributed within a given interpolymer molecule and wherein substantially all of the interpolymer molecules have the same ethylene/comonomer ratio within that interpolymer. The term "linear ethylene/α-olefin polymers" does not refer to high pressure branched polyethylene which is known to those skilled in the art to have numerous long chain branches. Typically, the linear homogeneously branched ethylene/α-olefin polymer is an ethylene/α-olefin interpolymer, wherein the α-olefin is at least one C_3-C_{20} α-olefin (e.g., propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene and the like), preferably at least one C_5-C_{20} alpha-olefin, especially wherein at least one of the α-olefins is 1-octene. Most preferably, the ethylene/α-olefin interpolymer is a copolymer of ethylene and a C_3-C_{20} α-olefin, especially an ethylene/C_5-C_{20} α-olefin copolymer, most preferably an ethylene/C_7-C_{20} α-olefin copolymer.

Substantially linear ethylene/α-olefin interpolymers are not in the same class as traditional linear ethylene/α-olefin polymers (e.g., heterogeneously branched linear low density polyethylene, linear high density polyethylene, or homogeneously branched linear polyethylene), nor are they in the same class as traditional highly branched low density polyethylene.

Long chain branching is defined herein as a chain length of at least 6 carbons, above which the length cannot be distinguished using ^{13}C nuclear magnetic resonance spectroscopy. The long chain branch can be as long as about the same length as the length of the polymer back-bone. However, the long chain branch is longer than the short chain branch resulting from incorporation of the comonomer. For example, an ethylene/1-octene

long chain branched copolymer will have a short chain branch length of six carbons and a long chain branch length of at least seven carbons.

Long chain branching can be determined for ethylene homopolymers and certain copolymers by using ^{13}C nuclear magnetic resonance (NMR) spectroscopy and is quantified using the method of Randall (Rev. Macromol. Chem. Phys., C29 (2&3), p. 285-297), the disclosure of which is incorporated herein by reference.

The homogeneous linear ethylene/α-olefin polymers and the substantially linear ethylene/α-olefin polymers or copolymers for use in the present invention are interpolymers of ethylene with at least one C_3-C_{20} α-olefin and/or C_4-C_{18} diolefins. Copolymers of ethylene and 1-octene are especially preferred. The term "interpolymer" is used herein to indicate a copolymer, or a terpolymer, or the like. That is, at least one other comonomer is polymerized with ethylene to make the interpolymer.

Other unsaturated monomers usefully copolymerized with ethylene include, for example, ethylenically unsaturated monomers, conjugated (e.g., piperylene) or nonconjugated dienes (e.g., ethylidene norbornadiene), polyenes, etc. Preferred comonomers include the C_3-C_{20} α-olefins especially propene, isobutylene, 1-butene, 1-hexene, 4-methyl-1-pentene, and 1-octene.

The density of the linear or substantially linear ethylene/α-olefin interpolymers or copolymers (as measured in accordance with ASTM D-792) for use in the present invention is generally from about 0.85 g/cm^3 to about 0.92 g/cm^3, preferably from about 0.86 g/cm^3 to about 0.90 g/cm^3, more preferably from about 0.865 g/cm^3 to about 0.89 g/cm^3, and especially from about 0.865 g/cm^3 to about 0.88 g/cm^3.

Other preferred comonomers (with ethylene) include styrene, halo- or alkyl substituted styrenes, tetrafluoroethylene, vinylbenzocyclobutane, 1,4-hexadiene, and naphthenics (e.g., cyclopentene, cyclohexene and cyclooctene).

The molecular weight of the linear or substantially linear ethylene/α-olefin polymers for use in the present invention is conveniently indicated using a melt index measurement according to ASTM D-1238, Condition 190°C/2.16 kg (formerly known as "Condition (E)" and also known as I_2). Melt index is inversely proportional to the molecular weight of the polymer. Thus, the higher the molecular weight, the lower the melt index, although the relationship is not linear. The melt index for the linear or substantially

linear ethylene/α-olefin polymers useful herein is generally from about 0.01 grams/10 minutes (g/10 min) to about 1000 g/10 min, preferably from about 1 g/10 min to about 100 g/10 min, and especially from about 5 g/10 min to about 100 g/10 min.

Another measurement useful in characterizing the molecular weight of the linear or the substantially linear ethylene/α-olefin polymers is conveniently indicated using a melt index measurement according to ASTM D-1238, Condition 190°C/10 kg (formerly known as "Condition (N)" and also known as I_{10}). The ratio of the I_{10} and the I_2 melt index terms is the melt flow ratio and is designated as I_{10}/I_2. For the substantially linear ethylene/α-olefin polymers used in the compositions of the invention, the I_{10}/I_2 ratio indicates the degree of long chain branching, i.e., the higher the I_{10}/I_2 ratio, the more long chain branching in the polymer. The I_{10}/I_2 ratio of the substantially linear ethylene/α-olefin polymers is preferably at least about 7, especially at least about 8. The upper I_{10}/I_2 ratio of the substantially linear ethylene/α-olefin polymers is preferably as high as about 50, especially as high as about 15. The I_{10}/I_2 ratio of the linear homogeneously branched ethylene/α-olefin polymers is generally about 6.

Preparation of suitable coalesced foam strand materials desirably uses conventional extrusion procedures and apparatus such as those detailed in USP 3,573,152, and USP 4,824,720. The teachings of these patents are incorporated herein in their entirety.

In a conventional extrusion foaming process, one converts polymer constituents into a polymer melt and incorporates a blowing agent and, if desired, other additives such as a nucleator, into the polymer melt to form a foamable gel. One then extrudes the foamable gel through a die and into a zone of reduced or lower pressure that promotes foaming to form a desired product. The reduced pressure is lower than that under which the foamable gel is maintained prior to extrusion through the die. The lower pressure may be superatmospheric or subatmospheric (vacuum), but is preferably at an atmospheric level.

In making coalesced foam strand products of the present invention, one passes the foamable gel through a multi-orifice die into a zone of lower pressure that favors foaming. The orifices are arranged so that contact between adjacent streams of the molten extrudate occurs during the foaming process and the contacting surfaces adhere to one another with sufficient adhesion to result in a unitary foam structure. The streams of molten

extrudate exiting the die take the form of strands or profiles, which desirably foam, coalesce, and adhere to one another to form a unitary structure. Desirably, the coalesced individual strands or profiles stay adhered to one another in a unitary structure to prevent strand delamination under stresses encountered in preparing, shaping, and using the foam.

Before extruding foamable gel through a die, one typically cools the foamable gel from a temperature that promotes melt mixing to a lower, optimum foaming temperature. The gel may be cooled in the extruder or other mixing device or in separate coolers. The optimum foaming temperature typically exceeds each polymer constituent's glass transition temperature (T_g), or for those having sufficient crystallinity to have a melt temperature (T_m), near the T_m. "Near" means at, above, or below and largely depends upon where stable foam exists. The temperature desirably falls within 30° centigrade (°C) above or below the T_m. For foams of the present invention, an optimum foaming temperature is in a range in which the foam does not collapse.

The blowing agent may be incorporated or mixed into the polymer melt by any means known in the art such as with an extruder, mixer, or blender. The blowing agent is mixed with the polymer melt at an elevated pressure sufficient to prevent substantial expansion of the melt polymer material and to generally disperse the blowing agent homogeneously therein. Optionally, a nucleator may be blended in the polymer melt or dry blended with the polymer material prior to plasticizing or melting.

Any conventional blowing agent may be used to prepare the coalesced foam strand products of the present invention. USP 5,348,795 discloses a number of suitable blowing agents at column 3, lines 15-61, the teachings of which are incorporated herein by reference. USP 5,527,573 also discloses a number of suitable blowing agents at column 4, line 66 through column 5, line 20, the teachings of which are incorporated herein by reference. Preferred blowing agents include aliphatic hydrocarbons having 1-9 carbon atoms, especially propane, n-butane and isobutane, more preferably isobutane.

Foams of the present invention may also be made using an accumulating extrusion process and apparatus such as that shown in USP 4,323,528 and USP 5,817,705, the teachings of which are incorporated herein by reference.

In addition to direct extrusion of the desired shape, any method of producing the desired foam shape may be employed such as forming the extruded foam by molds, pressing forming plates against the foam as it exits the die, or pressing onto the foam surface

with rollers or belts. This operation may be done immediately as the foam exits the die or after the foam has cooled in order to form the foam into the desired shape. Alternatively, the desired shape may be cut from a solid block of foam by any method known by artisans skilled in foam fabrication.

The following examples illustrate, but do not in any way limit the scope of the present invention. Arabic numerals illustrate examples (Ex) of the invention and letters of the alphabet designate comparative examples (Comp Ex).

Ex 1

Begin with an extruded polypropylene foamed strand plank that has a density of 1.0 pound per cubic foot (pcf) (16.1 kg/m^3), a length of 8.2 feet (2.5 meters), a width of 24 inches (61 centimeters (cm)) and a thickness of 2 inches (5.1 cm). Machine or cut a "sawtooth" profile like that shown in Figs. 2 and 3 into one major planar surface of the plank or board. The profile establishes a vertical distance from peak or tooth to valley of 1.5 inch (3.8 cm) and a vertical distance from valley floor to the other planar surface of 0.5inch (1.3 cm). Trim the resulting profiled board so that it has a width of 18 inches (45.7 cm) and a length of 4 feet (1.2 meters). The trimmed board is suitable for insertion between building rafters after one end of the trimmed board is fastened, planar side down, against an upper portion of a external wall as illustrated in Fig. 1. After being fastened in this manner, bending the trimmed board at an angle of 90°from vertical over a sharp edge such as that established by a sill plate, induces no foam breakage or foam surface cracking or rupturing. After bending at the 90° angle such that the board is oriented horizontal and disposed across the sill plate, the board rebounds sufficiently to establish an angle of at least 20 degrees from horizontal Altering the profile as shown in any of Figs. 4-7 and 9-13 yields similar results. Air flow capacity may be increased, if desired, by adding one or more passageways or conduits that traverse the length of one or more of the teeth or peaks.

Ex. 2

Replicate Ex. 1, but substitute a foam made from a two pound per cubic foot (pcf) (32 kilograms per cubic meter (kg/m^3)) for the polypropylene foam of Ex. 1. The trimmed board functions in a manner similar to that of the polypropylene foam of Ex. 1 in that it rebounds to establish an angle of at least 20 degrees from horizontal and suffers no foam breakage or foam surface cracking or rupturing.

It is believed that the foam of Ex. 2. will have a greater tendency to soften and sag, when exposed to elevated temperatures present in an attic space on a hot and sunny summer day in the Southwestern United States, than the polypropylene foam of Ex. 1. This belief stems from a comparison of polymer melt temperatures. If one expects such sagging, any number of means may be employed to counteract sagging such as, for example, use of fasteners, adhesives or both, either in place of or in addition to support means such as a transverse brace fastened to undersides of rafters. One such support means is a nominal 1 inch by 4 inch board that is fastened to the underside of rafters at a point intermediate between where one end of the foam board is fastened to the external wall and the other end of the foam board.

Similar results should follow with substitution of foams made from extrusion molded foams as well as foams made from expanded polymer foam beads for the extruded polymer foams of either Ex. 1 or Ex. 2.

Comp Ex A

Prepare a thermoformed polystyrene foam sheet having a shape similar to that shown in USP 6,347,991, but with no hinge or fold lines. Begin with an extruded polystyrene foam sheet having a thickness of 2 millimeters (mm), heat the sheet to a temperature above its heat distortion temperature of 100°C and then use a thermoforming mold to yield the shape. The thermoformed sheet, when bent at a 90° angle, evidences irregular cracking and some fracturing. Bending the sheet at a lesser angle to avoid such cracking and fracturing allows the sheet to rebound almost to its unbent shape, if not fully to its unbent shape, but renders the sheet unsuitable for use as a substitute for the foam of Ex. 1. Adding hinge or fold lines and avoiding multiple flexures of the sheet about the hinge or fold lines reduces the tendency toward cracking or fracturing, but effectively destroys the ability of the sheet to rebound by as much as 25%, if it rebounds at all.